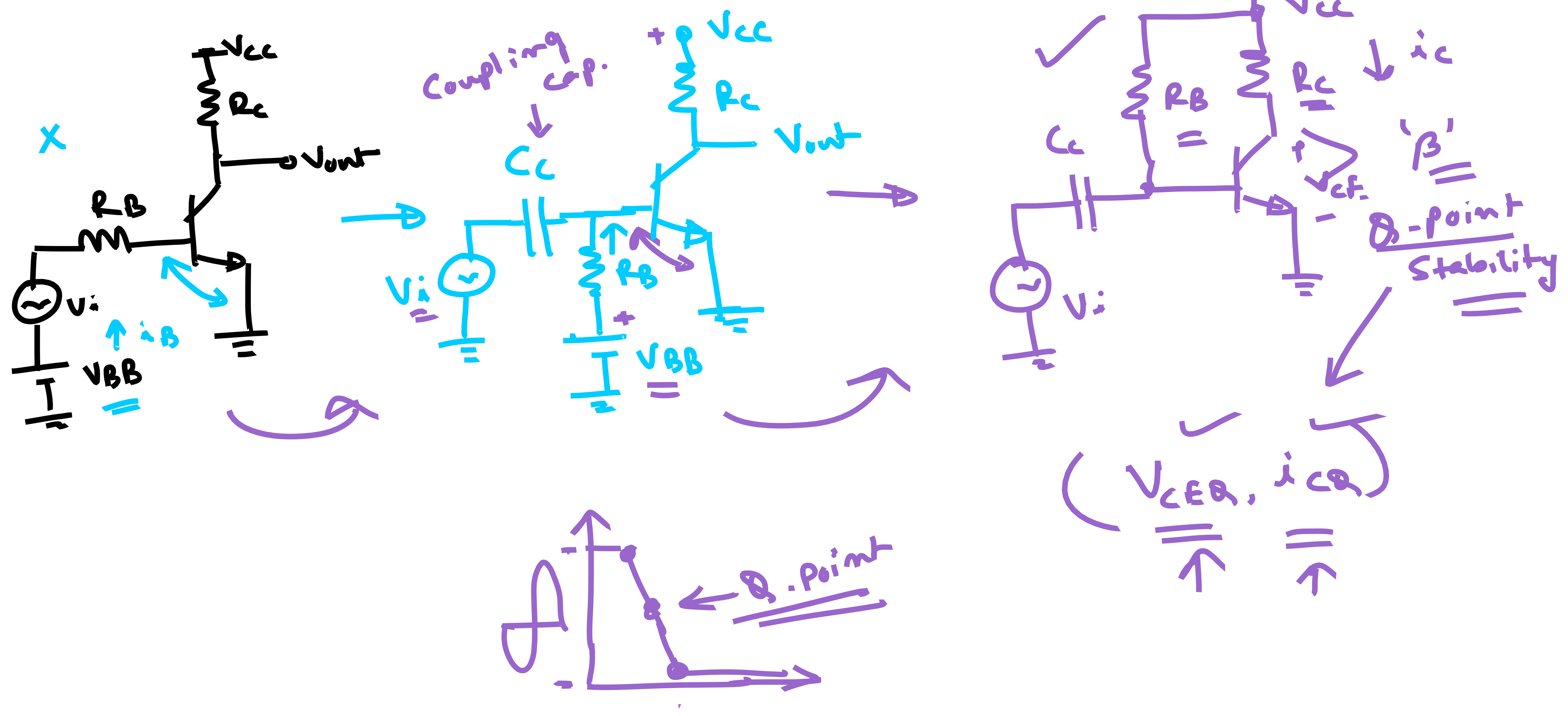
Biasing schemes of BJT circuits



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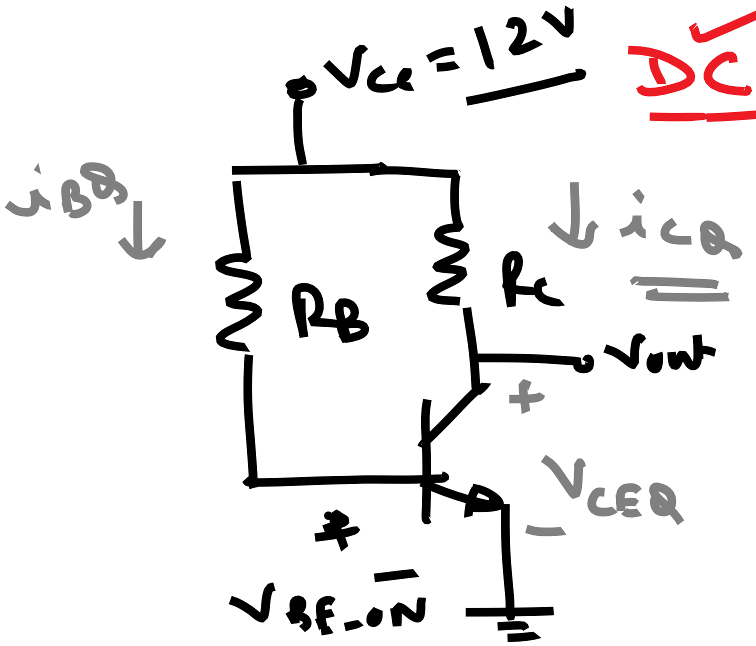

DC Analysis

$I_{CQ} = 1\ mA$

$V_{CEQ} = 6\ V. \leftarrow$ Q-Point

$\beta = 100$

$R_B, R_c = ??$

$V_{CEQ} = V_{cc} - i_{CQ} \cdot R_c$

$6 = 12 - 1 \times R_c$

$R_c = 6\ K\Omega.$

$i_{CQ} = \beta\, i_{BQ}.$

$i_{BQ} = \dfrac{i_{CQ}}{\beta} = 10\ \mu A$

$R_B = \dfrac{V_{cc} - V_{BE\text{-}ON}}{i_{BQ}}$

$i_{BQ} = \dfrac{V_{cc} - V_{BE\text{-}ON}}{R_B} \rightarrow$ fixed

$R_B = 1.13\ M\Omega \rightarrow$ "IC"

$V_{CEQ} = V_{cc} - i_{CQ} \cdot R_c = V_{cc} - \beta\, i_{BQ} \cdot R_c$

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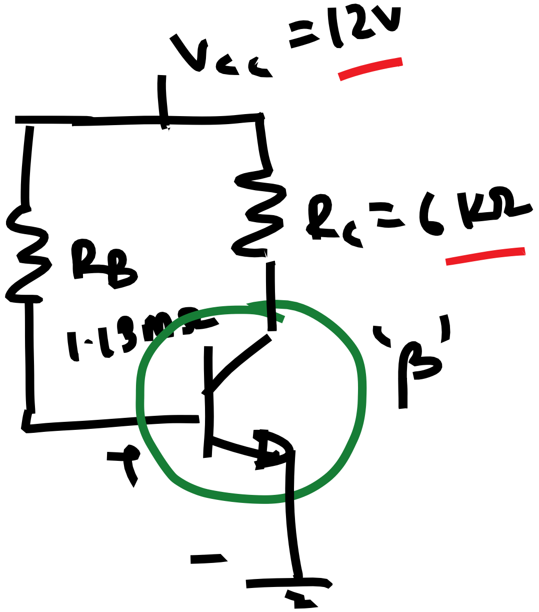
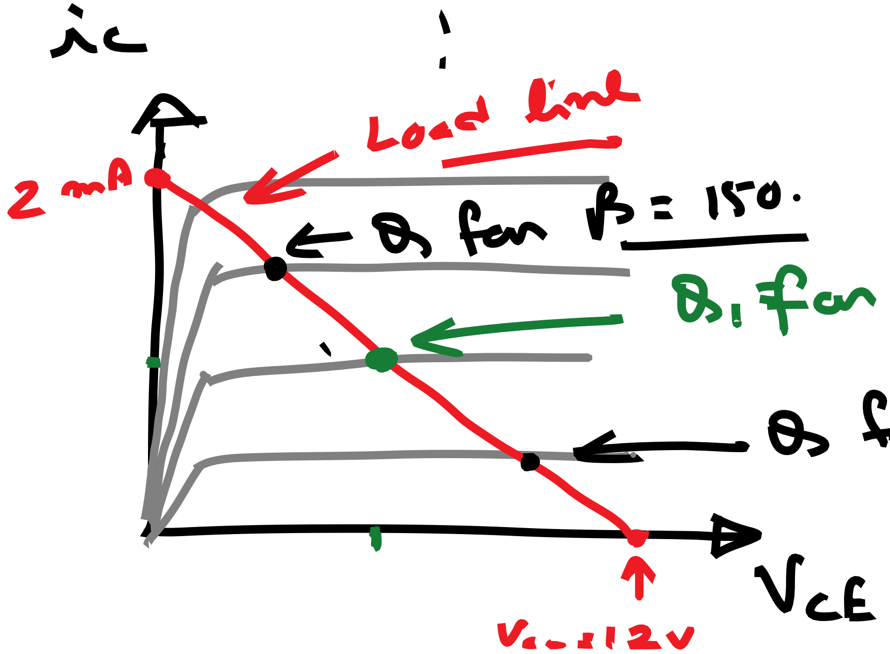


$$\begin{cases} I_{CQ} = \beta \cdot I_{BQ} = \beta \cdot \dfrac{V_{CC} - V_{BE\text{-}ON}}{R_B} \\ V_{CEQ} = V_{CC} - I_{CQ} \cdot R_C \end{cases}$$

$$\boxed{50 \le \beta \le 150}$$

$\beta = 100$, $I_{CQ} = 1\,mA$, $V_{CEQ} = 6\,V$.



	$\beta = 50$	$\beta = 100$	$\beta = 150$
I_{CQ}(mA)	0.5	1	1.5
V_{CEQ}(V)	9	~~12~~	3

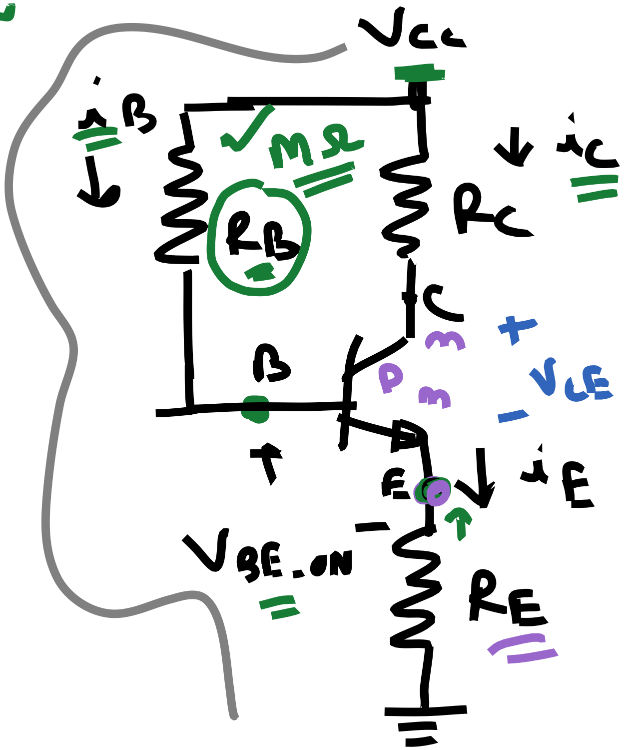
* → 6

Correction

Biasing schemes of BJT circuits

$\downarrow V_{BE} = V_B - V_E \uparrow$ $\quad T\uparrow$

$i_E = \frac{1+\beta}{\beta}\, i_C \uparrow$

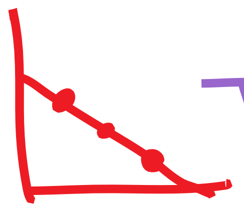


$$V_{cc} = i_B \cdot R_B + V_{BE\text{-}ON} + i_E R_E \quad ; \quad i_E = (1+\beta)\, i_B$$

$$V_{cc} = i_B \cdot R_B + V_{BE\text{-}ON} + (1+\beta)\, i_B \cdot R_E$$

$$i_B = \frac{V_{cc} - V_{BE\text{-}ON}}{R_B + (1+\beta) R_E} \quad ; \quad i_C = \beta\, i_B$$

$$i_C = \beta \times \frac{V_{cc} - V_{BE\text{-}ON}}{R_B + (1+\beta) R_E}$$



$T\uparrow,\ I\uparrow$

$(1+\beta) R_E >> R_B$

$$i_C = \beta \times \frac{V_{cc} - V_{BE.ON}}{(1+\beta) R_E}$$

$$\rightarrow\ i_C = \frac{V_{cc} - V_{BE.ON}}{R_E}$$

$$V_{CE} = V_{cc} - i_C R_C - i_E R_E$$

$$= V_{cc} - i_C R_C - \underbrace{\left(\frac{1+\beta}{\beta}\right)}_{\approx 1} i_C R_E$$

$$= V_{cc} - i_C R_C - i_C R_E$$

$$V_{CE} = V_{cc} - (R_C + R_E) \times \frac{V_{cc} - V_{BE\text{-}ON}}{R_E}$$

β' increase

$i_C\uparrow \rightarrow V_E\uparrow \rightarrow V_{BE}\downarrow \rightarrow i_B\downarrow \rightarrow i_C\downarrow$

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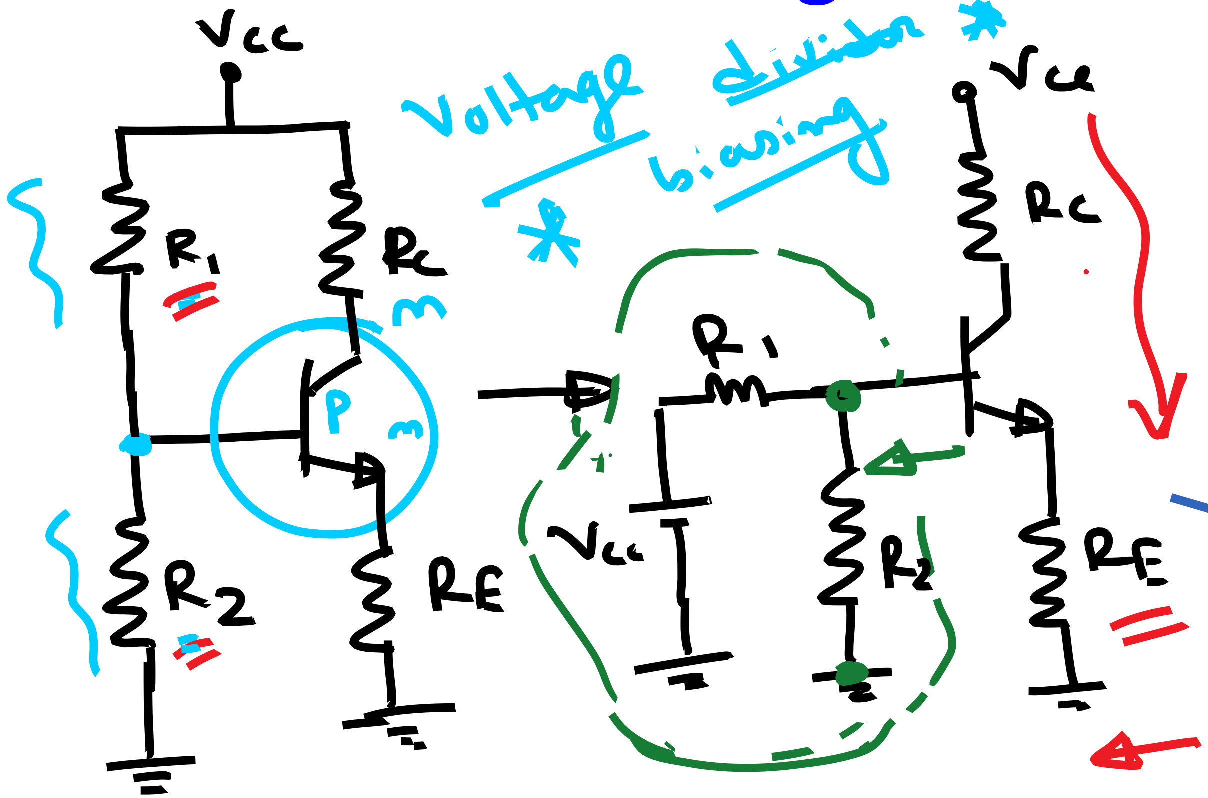
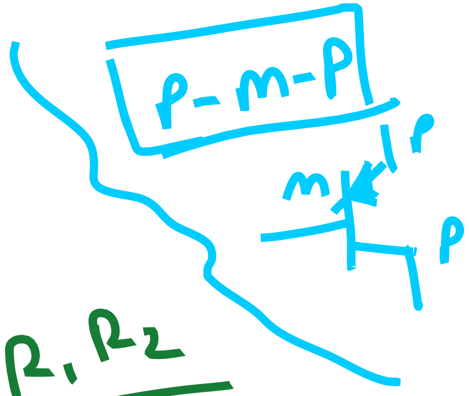
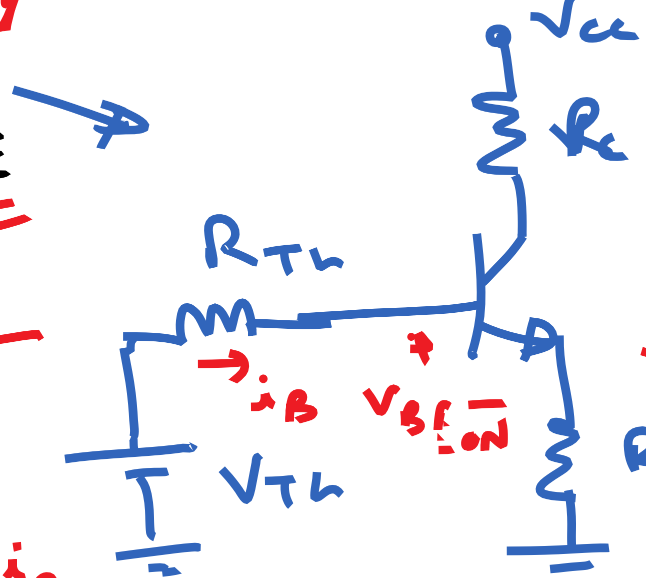




$$V_{Th} = \frac{R_2}{R_1+R_2} V_{cc}$$

$$R_{Th} = R_1 \parallel R_2 = \frac{R_1 R_2}{R_1+R_2}$$



$V_{CE} \rightarrow$ independent of "β"

$R_{Th} \approx 0.1\,(1+\beta) R_E$

$$V_{Th} = i_B R_{Th} + V_{BE\_ON} + i_E \cdot R_E$$

$$V_{Th} = i_B R_{Th} + V_{BE\_ON} + (1+\beta) R_E\, i_B$$

$$i_B = \frac{V_{Th} - V_{BE\_ON}}{R_{Th} + (1+\beta) R_E} \;;\quad i_C = \beta \times \frac{V_{Th} - V_{BEON}}{R_{Th} + (1+\beta) R_E} \rightarrow R_{Th} \ll (1+\beta) R_E \rightarrow i_C = \frac{V_{Th} - V_{BEON}}{R_E}$$